

GENERATIONS OF COMPUTERS

Zeroth Generation

The term Zeroth generation is used to refer to the period of development of computing, which predated the commercial production and sale of computer equipment. The period might be dated as extending from the mid-1800s. In particular, this period witnessed the emergence of the first electronics digital computers on the ABC, since it was the first to fully implement the idea of the stored program and serial execution of instructions. The development of EDVAC set the stage for the evolution of commercial computing and operating system software. The hardware component technology of this period was electronic vacuum tubes. The actual operation of these early computers took place without the benefit of an operating system. Early programs were written in machine language and each contained code for initiating operation of the computer itself. This system was clearly inefficient and depended on the varying competencies of the individual programmer as operators.

The First Generation, 1951–1956

The first generation marked the beginning of commercial computing. The first generation was characterized by high-speed vacuum tube as the active component technology. Operation continued without the benefit of an operating system for a time. The mode was called "closed shop" and was characterized by the appearance of hired operators who would select the job to be run, initial program load the system, run the user's program, and then select another job, and so forth. Programs began to be written in higher level, procedure-oriented languages, and thus the operator's routine expanded. The operator now selected a job, ran the translation program to assemble or compile the source program, and combined the translated object program along with any existing library programs that the program might need for input to the linking program, loaded and ran the composite

linked program, and then handled the next job in a similar fashion. Application programs were run one at a time, and were translated with absolute computer addresses. There was no provision for moving a program to different location in storage for any reason. Similarly, a program bound to specific devices could not be run at all if any of these devices were busy or broken.

At the same time, the development of programming languages was moving away from the basic machine languages; first to assembly language, and later to procedure oriented languages, the most significant being the development of **FORTRAN**.

The Second Generation, 1956–1964

The second generation of computer hardware was most notably characterized by transistors replacing vacuum tubes as the hardware component technology. In addition, some very important changes in hardware and software architectures occurred during this period. For the most part, computer systems remained card and tape-oriented systems. Significant use of random access devices, that is, disks, did not appear until towards the end of the second generation. Program processing was, for the most part, provided by large centralized computers operated under mono-programmed batch processing operating systems.

The most significant innovations addressed the problem of excessive central processor delay due to waiting for input/output operations. Recall that programs were executed by processing the machine instructions in a strictly sequential order. As a result, the CPU, with its high speed electronic component, was often forced to wait for completion of I/O operations which involved mechanical devices (card readers and tape drives) that were order of magnitude slower. These hardware developments led to enhancements of the operating system. I/O and data channel communication and control became functions of the operating system, both to relieve the application programmer from the difficult details of I/O programming and to protect the integrity of the system to provide improved service to users by segmenting jobs and running shorter jobs first (during "prime time") and relegating

longer jobs to lower priority or night time runs. System libraries became more widely available and more comprehensive as new utilities and application software components were available to programmers.

The second generation was a period of intense operating system development. Also it was the period for sequential batch processing. Researchers began to experiment with multiprogramming and multiprocessing.

The Third Generation, 1964-1979

The third generation officially began in April 1964 with IBM's announcement of its System/360 family of computers. Hardware technology began to use integrated circuits (ICs) which yielded significant advantages in both speed and economy. Operating System development continued with the introduction and widespread adoption of multiprogramming. This marked first by the appearance of more sophisticated I/O buffering in the form of spooling operating systems. These systems worked by introducing two new systems programs, a system reader to move input jobs from cards to disk, and a system writer to move job output from disk to printer, tape, or cards.

The spooling operating system in fact had multiprogramming since more than one program was resident in main storage at the same time. Later this basic idea of multiprogramming was extended to include more than one active user program in memory at time. To accommodate this extension, both the scheduler and the dispatcher were enhanced. In addition, memory management became more sophisticated in order to assure that the program code for each job or at least that part of the code being executed was resident in main storage. Users shared not only the system's hardware but also its software resources and file system disk space.

The third generation was an exciting time, indeed, for the development of both computer hardware and the accompanying operating system. During this period, the topic of operating systems became, in reality, a major element of the discipline of computing.

The Fourth Generation, 1979 – Present

The fourth generation is characterized by the appearance of the personal computer and the workstation. Miniaturization of electronic circuits and components continued and Large Scale Integration (LSI), the component technology of the third generation, was replaced by Very Large

Scale Integration (VLSI), which characterizes the fourth generation. However, improvements in hardware miniaturization and technology have evolved so fast that we now have inexpensive workstation-class computer capable of supporting multiprogramming and time-sharing. Hence the operating systems that supports today's personal computers and workstations look much like those which were available for the minicomputers of the third generation. Examples are Microsoft's DOS for IBM-compatible personal computers and UNIX for workstation. However, many of these desktop computers are now connected as networked or distributed systems. Computers in a networked system each have their operating system augmented with communication capabilities that enable users to remotely log into any system on the network and transfer information among machines that are connected to the network. The machines that make up distributed system operate as a virtual single processor system from the user's point of view; a central operating system controls and makes transparent the location in the system of the particular processor or processors and file systems that are handling any given program.